# RANDOM ACCESS COMMUNICATIONS CHANNEL FOR DATA SERVICES

## BACKGROUND OF THE INVENTION

I. Field of the Invention

The present invention relates to a random access communications channel for data services. More particularly, the present invention relates to a method for sharing the resources of existing channels in a cellular telephone communications system among a large number of packet data users, each having a variable and unpredictable demand for transmission resources.

II. Description of the Related Art

Cellular telephone systems have traditionally provided voice services, patterned on the land telephone system model. In that model, a user places a call by requesting a connection between one telephone terminal and another such terminal. Once the connection is established, it remains in place until the calling party or the called party requests that the connection be released. While the connection is established, the telephone system dedicates system resources, such as trunk bandwidth, to the call. The resources are dedicated at all times, regardless of whether the callers talk or are silent. The system resources are not shared among calls.

The land telephone model is followed in conventional cellular systems. For example, two systems that follow that model are the Advanced Mobile Phone System ("AMPS") cellular system, described in "Mobile Station/Land Station Compatibility Specification," ANSI/EIA/TIA-553 (September 1993), and the time division multiple access ("TDMA") system, described in "Cellular System Dual-Mode Mobile Station/Base Station Compatibility Standard," EIA/TIA/IS-54-B (September 1992). The code division multiple access ("CDMA") cellular system, described in "Mobile Station/Base Station Compatibility Standard for Dual-Mode Wideband Spread Spectrum Cellular System," TIA/EIA/IS-95, Telecommunications Industry Association (July 1993), allows sharing of radio bandwidth, but follows the land telephone model for connections between the mobile switching center ("MSC") and the public switched telephone network ("PSTN").

The CDMA system described above uses a 1.23 MHz bandwidth to serve multiple calls, using a CDMA scheme. Each user is assigned a unique code. All user terminals sharing the radio channel transmit simultaneously, and the receivers use the unique code to identify and decode a signal from the terminal that is to be received. The process is limited by the interference generated by the other transmitters. So long as the desired signal can be maintained sufficiently strong relative to the total interference, the signal can be successfully demodulated. When the number of users exceeds the CDMA channel's capacity, however, the necessary signal strength cannot be maintained. This CDMA cellular system provides for a total of 64 forward link channels per cell in each 1.23 MHz band. Experiments have shown that such a system can support more than 60 simultaneous calls per cell in the 1.23 MHz bandwidth under benign propagation and interference conditions.

The CDMA cellular telephone system also provides a means of serving a large population of cellular telephone units, most of which are idle, i.e., not involved in a call. These idle units monitor a special control channel known as the "Paging Channel," which continuously transmits system information and paging messages. Paging messages are used to inform a mobile terminal that a caller wishes to establish a call connection to the mobile. Each Paging Channel has one or more associated "Access Channels." The Access Channels use multiple-access protocols, by which the mobile terminals transmit call requests (originations) and answer paging messages. When a connection is established, the cellular base station assigns the mobile station a dedicated "Traffic Channel" to carry the voice information for the duration of the call.



The CDMA system was designed to exploit the idleness of the mobile terminals. If this were not so, the number of mobile terminals supported would be limited to fewer than 64 per cell, because of the limited number of channels provided in the system design. Because most terminals are idle, the system can support several orders of magnitude more mobile terminals per cell, thereby justifying the choice of 64 channels as an upper limit.

Users of packet data services often utilize system resources in a manner that varies over the course of the packet data session. File transfers, e-mail, and information retrieval are examples of packet data services that follow this pattern. For these services, a few packets are sent while the user selects the file, e-mail, or other information to be retrieved, then a long sequence of packets is sent or received while the information is transferred.

In other types of data packet services, only a few packets are sent during an exchange of data, and the exchanges occur on an irregular basis. Examples of such services include: credit verification, message and paging services, order entry, and delivery routing.

The manner in which these two types of data packet services utilize resources suggests that a packet service should provide two basic service modes. First, for those cases where large amounts of data are to be transferred, a service mode should be available that optimizes the data throughput. Second, for cases where packet transmission is infrequent and irregular, dedicating a channel assignment to each user would be wasteful of system resources, because the dedicated channels would be unused most of the time. For this second case, then, a service mode should be available that optimizes the sharing of resources, i.e., optimizing channel usage. It should be possible for a packet service to switch between the two modes in response to usage demand.

Conventional cellular systems, including CDMA, however, have neither the capability to efficiently and effectively handle both types of data packet services, nor the capability to switch between the two. While the CDMA Traffic Channels do provide dedicated channel assignments and can thus be used to handle high-throughput packet service to prevent the throughput reduction resulting from channel sharing, they are inefficient for low throughput, irregular and infrequent data packet transmissions. Thus, a multiple-access protocol is required for a service mode that optimizes sharing of resources.

Despite providing multiple-access protocols, the existing CDMA Paging and Access Channels operate in a manner that is not well suited to data packet services. For example, those channels can support only a small packet size, which reduces the effective throughput of the channel because each packet contains header information as overhead. This overhead occupies a greater fraction of the available channel bandwidth when the packets are small.

Furthermore, the Paging and Access Channels cannot support long packet sizes because of their access methods. The Access Channel provides no power control feedback that would allow the base station to maintain the mobile